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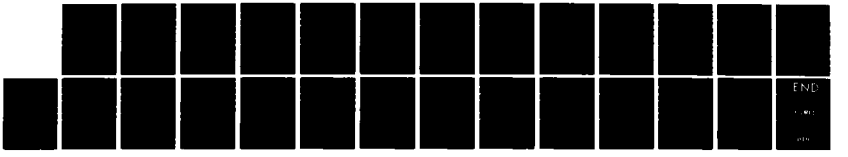

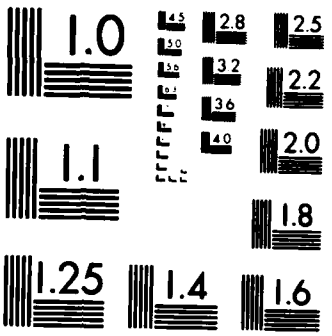

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Provides procedures for evaluating performance and endurance of reciprocating internal combustion engines under laboratory conditions. Power train components such as transmissions and transmission steering devices are not covered in this TOP.

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(Test Operating Procedure)

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

AMSTE-RP-702-101
*Test Operations Procedure 2-2-700 24 January 1985
AD No.

LABORATORY TESTS OF RECIPROCATING INTERNAL COMBUSTION ENGINES

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1. SCOPE. This TOP provides procedures for evaluating performance and endurance of reciprocating internal combustion engines under laboratory conditions. Power train components such as transmissions and transmission steering devices are covered in MTP 2-2-703.[1]**

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENT
Test chamber	
Test engine(s)	

*This TOP supersedes MTP 2-2-700 dated 2 November 1966.

**Footnote numbers correspond to reference numbers in Appendix B.

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2.2 Instrumentation.

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMNT*
Exhaust sampling pump (e.g., Robert Bosch EFAW 65)	
Analyzing instrument (e.g., Robert Bosch EFAW 68)	
Dynamometer	±3% of reading
Tachometer	±0.5% of full scale
Pressure gages	±2% indicated reading
Thermocouples and recorders	±1° C (2° F)
Barometer	±0.05 cm (0.02 in.) mercury
Thermometers (as appropriate)	±1° C (2° F)
Manometers (as appropriate)	±0.25 cm (0.1 in.) indicated readings
Electric revolution counter Electronic decade counter/pulse generator Mechanical counter and stopwatch	±0.5% of the observed reading or ±10 revolutions, whichever is less
Magnetic pickup (as appropriate)	±0.25% of true reading
Potentiometer	
Psychrometer	
Electronic spark protractor	
Viscous flow meter, rotometer, flow orifice, venturi, or integrating gas meter to cover a range to 0.06 m^3/min (2 ft^3/min)	±0.003 m^3/min (0.1 ft^3/min)

3. REQUIRED TEST CONDITIONS.

3.1 Initial Inspection.

3.1.1 Method.

a. Visually inspect the test engine, upon its arrival, for damage.

b. Measure and record the physical description of the test engine as described in MIL-STD 1400.[2]

3.1.2 Data Required. Record the following:

a. Any damage of the test engine observed upon its arrival
b. Data required in Appendix D of MIL-STD 1400

3.2 Initial Running.

3.2.1 Method.

a. Place the test engine in the test chamber.

b. Install and record the type fuel, oil, and coolant (when applicable) to be used in the engine.

c. Start the engine and assure smooth operation. Run engine according to manufacturer's recommended procedures.

3.2.2 Data Required. Record the following:

a. Type fuel
b. Type oil
c. Type coolant (when applicable)
d. Failures (if any) or irregularities in operation

3.3 Instrumentation. NOTE: MTP 2-1-002[3] contains a general discussion of automotive laboratory instrumentation.

a. All instrumentation shall be calibrated before each test is conducted.

b. Monitor all instrumentation throughout testing, and record any failures.

3.3.1 Speed.

a. Engine crankshaft speed. Install one of the following:

(1) Automatic electric revolution counter w/synchronized timer
(2) Electronic decade counter and magnetic pickup or pulse generator on the engine crankshaft or dynamometer shaft
(3) Mechanical counter

b. Turbocharger speed (when applicable). Install a magnetic pickup on the turbocharger shaft and a suitable counting and indicating device in its peripheral plane. NOTE: The pickup may consist of a magnetized nut or other ferrous part attached to the turbocharger shaft and a sensitive coil positioned in the peripheral plane of the rotating element.

3.3.2 Temperatures. All temperature-measuring devices shall be connected through a selector switch to a calibrated potentiometer. All thermometers and thermocouples shall be shielded from radiation of the engine.

a. Ambient air. Install four thermocouples/thermometers equi-distant around the engine at least 1.2 m (4 ft) away and at half the maximum vertical dimension of the engine.

b. Intake air. Install a thermocouple in the air intake stream at least 15 cm (6 in.) from the manifold and air cleaner. (If the air cleaner is closer than 15 cm, make the connection as far as possible from the manifold.) When applicable, measure inlet and outlet temperatures to the turbocharger and after cooler, as well.

c. Exhaust. Install a thermocouple in the exhaust line about 5 cm (2 in.) downstream from the exhaust manifold outlet flange or as close as practical to the turbine inlet if a turbocharger is used. NOTE: At the discretion of the test director, gas temperatures in the exhaust outlet of each cylinder of a diesel engine can be measured.

d. Fuel. Install a thermocouple at the inlet to the carburetor for gasoline engines and at the outlet of the final filter or the inlet to the injection pump for diesel engines.

e. Coolant. Install a thermocouple at the coolant inlet to the engine and at the coolant outlet from the engine.

f. Lubricating oil. Do the following:

(1) Force-feed and splash systems - install a thermocouple in the sump wall so that the temperature is representative of the greater mass of lubricant and is not influenced by localized hot or cold spots.

(2) Full or force-feed systems - install a thermocouple in the oil gallery.

g. Cylinder head (air-cooled gasoline engines only). Install a thermocouple in the spark plug gasket for each cylinder.

3.3.3 Pressure. Use barometers and manometers to measure pressure in in. mercury, cm water, and use pressure gages to measure pressure in kPa. NOTE: Pressure lines shall be as straight as possible without any "U" bends or low spots that might trap liquids.

a. Barometric. Install a mercurial barometer (Weather Bureau type) near the engine.

b. Intake air.

(1) Gasoline engines (naturally aspirated). Install a manometer to a pressure tap in the manifold as near as possible to the carburetor flange.

(2) Diesel engines (naturally aspirated). Install a manometer to a pressure tap in the manifold as near as possible to the inlet flange.

(3) All engines equipped with blowers, mechanical superchargers, or turbochargers. Install manometer to pressure taps on the blower or supercharger, or on the inlet and discharge sides of the compressor of the turbocharger, or on the inlet and discharge sides of the intercooler or after cooler, if applicable.

NOTE: Measure pressure in in. mercury or cm water if necessary for very low pressure. Omit intake air pressure for small gasoline engines of less than 20 horsepower if carburetor is adversely affected.

(4) Install manometer to pressure taps on inlet and outlet sides of air cleaner.

c. Exhaust.

(1) Engines (naturally aspirated or supercharged). Install a manometer to a pressure tap as near as possible to the outlet flange of the exhaust manifold.

(2) Engines, turbocharged. Install manometers to pressure taps as near as possible to the outlet and inlet flange of the turbine.

(3) Engines, turbocharged with an exhaust diffuser. Install a manometer to the pressure tap 25 to 30 cm (10 to 12 in.) downstream from the diffuser.

d. Fuel.

(1) Gasoline engine with fuel pump. Install a pressure gage to a pressure tap in the discharge line of the fuel pump.

(2) Diesel engine. Install a pressure gage to a pressure tap at the outlet of the final fuel filter.

e. Lubricating oil (force-feed). Install a pressure gage to a pressure tap in the main oil header as close as practical to the discharge side of the lubricating oil pump.

f. Blow-by. Install a suitable meter such as a rotometer, viscous flow meter, flow orifice, venturi, or integrating gas meter at the oil breather tube.

3.3.4 Fuel Consumption. Install a flow meter in the fuel inlet line to the carburetors or injection pump.

3.3.5 Exhaust Smoke.

a. Install a sampling probe in the exhaust pipe midway between and parallel to the pipe walls and between 30 and 152 cm (12 and 60 in.) from the exhaust manifold. NOTE: At the probe position, the exhaust pipe inside area shall not be larger than 125% of the exhaust manifold outlet area.

b. Connect the exhaust probe to the sampling pump (Robert Bosch EFAW 65) with a tube that has an inside diameter of no more than 0.6 cm (1/4 in.) and a length of no more than 61 cm (24 in.).

3.3.6 Spark Advance (gasoline engines only). Install an electronic spark protractor on the distributor of the engine. (Since such a device may not measure total advance, centrifugal advance, or vacuum advance, a timing light with a degree wheel attached to the crankshaft pulley or harmonic balancer may be required.

3.3.7 Torque. Install a dynamometer to the output shaft of the engine. The coupling drive between the engine and dynamometer shall be suitable for operation through the engine speed range with a minimum of power loss or out-of-balance.

4. TEST PROCEDURES. Before any testing is conducted, set the timing and idle speed to the manufacturer's specifications.

4.1 Maximum Output.

4.1.1 Net Horsepower.

a. Record the following at the beginning of the test and at the beginning of testing at each speed:

(1) Ambient temperature: wet bulb and dry bulb

(2) Barometric pressure

b. Start the engine and stabilize it at the proposed maximum continuous duty speed. Engine rpm during the stabilized data observation period shall be held as constant as possible by means of the applied dynamometer load and shall be permitted to vary no more than 1% or ±10 rpm, whichever is less.

c. Adjust the engine to maximum horsepower for at least 10 minutes.

d. Record the following:

(1) Engine speed
(2) Dynamometer scale reading
(3) Air intake rate
(4) Intake air pressure
(5) Exhaust pressure
(6) Fuel pressure
(7) Oil pressure
(8) Intake air temperature
(9) Exhaust temperature
(10) Fuel temperature
(11) Oil temperature
(12) Fuel intake rate
(13) Spark advance (gasoline engines only)
(14) Exhaust smoke analysis (diesel engines only)

e. Increase the engine speed 200 rpm for diesel engines or 400 rpm for gasoline, and stabilize it.
f. Repeat steps c and d.
g. Repeat steps e and f until maximum engine speed is achieved
h. Decrease the engine speed 200 rpm for diesel engines or 400 rpm for gasoline, and stabilize it.
i. Repeat steps c and d.
j. Repeat steps h and i until original speed is achieved.
k. Stop the engine.

4.1.2 Gross Horsepower.

a. Remove the following nonessential accessories from the engine:

(1) Air cleaner(s)
(2) Muffler(s)
(3) Generator

b. Repeat the procedures of paragraph 4.1.1.

4.2 Accessory Losses.

a. Re-install the air cleaner(s) on the engine.
b. Repeat the procedures of paragraph 4.1.1.
c. Remove the air cleaner(s) and install the muffler(s) on the engine.
d. Repeat step b.
e. Remove the muffler(s) and install one of the following:

(1) Generator
(2) Fan

f. Repeat step b.

g. Continue selecting accessories and repeating step b until all accessories have been tested.

h. At the end of testing, replace all accessories and adjust to the slowest possible operational engine speed.

i. Stop the engine.

4.3 Motoring Friction. Friction horsepower is the power required to overcome engine friction.

a. Start the engine and run it at full throttle, maximum load, until stabilized temperatures are reached.

b. Turn off the ignition and reverse the dynamometer so that it is motoring the engine. Set the throttle wide open.

c. Open the intake and exhaust valves slightly, but check before full rotation for interference between the valves and piston at top dead center.

d. Motor the engine at top-rated speed and record the dynamometer scale reading. Do not take any readings within 1 minute of cutting the ignition.

e. Reduce the motoring speed 400 rpm and record the dynamometer scale readings.

f. Repeat step e until idle speed is reached.

g. Stop the engine and let it cool to ambient temperature.

h. Motor the engine at crank-speed and record the dynamometer scale reading.

i. Motor the engine at idle speed and record the dynamometer scale reading.

j. Stop the engine.

k. Reverse the dynamometer and replace the spark plugs or close the intake valves.

4.4 Blow-by. Location of blow-by measurement should consider the type PCV system used.

a. Seal all crankcase openings and system inlet/outlet passage except for the normal major outlet.

b. Start the engine and stabilize it at the slowest operational engine speed.

c. For a 10-minute interval, record blow-by and engine speed.

d. Increase the engine speed 200 rpm for diesel engines or 400 rpm for gasoline, and stabilize it.

e. Repeat step c.

f. Repeat steps d and e until maximum speed is achieved.

g. Stop the engine.

4.5 Fuel Consumption.

a. Start the engine and stabilize it at the slowest operational engine speed with zero load.

b. Run the engine as long as necessary for temperatures and pressures to stabilize. Record the following within the last 10 minutes:

(1) Engine speed
(2) Intake air pressure
(3) Rack position (diesel engines only)
(4) Dynamometer scale readings
(5) Fuel intake rate
(6) Air intake rate
(7) Fuel pressure

c. Keeping the engine speed constant, increase the load to 1/4 full load.

d. Repeat step b.

e. Repeat steps c and d for 1/2, 3/4, and full loads.

f. Increase engine speed 200 rpm and reduce the load to zero.

g. Repeat steps b through f until maximum engine speed is achieved.

h. Stop the engine.

4.6 Octane Requirements. Determine this in accordance with TOP 2-2-701.[4]

4.7 Cold Starting. Determine this characteristic of the test engine in accordance with TOP 2-2-650.[5]

4.8 Road Load Economy. Conduct this test in accordance with TOP 2-2-603.[6]

4.9 Performance Tests. When performance testing is to be conducted for a specific purpose, the test directive shall indicate which of the following performance tests shall be conducted.

4.9.1 Power Checks. Determine power capability of the engine by doing procedures specified in paragraphs 4.1.1 and 4.6.

4.9.2 Calibration. Determine calibration parameters by doing procedures specified in paragraphs 4.1.1, 4.5, 4.6, and 4.8.

4.9.3 Complete Performance. Determine complete performance characteristics by doing procedures specified in paragraphs 4.1.1, 4.1.2, 4.2, 4.3, 4.5, 4.6, 4.7, and 4.8.

4.10 Endurance Tests. When endurance tests are to be conducted for a specific purpose, the test directive shall indicate which of the following tests shall be conducted:

4.10.1 Fuel and Lubricant Compatibility. Determine this as described in applicable portions of TOP 2-2-701.

4.10.2 Acceptability.

a. Before starting the test, do procedures described in paragraphs 4.1.1 and 4.6.

b. Run the engine for 250 hours using the appropriate schedule from MIL-STD 1400.

c. Every 25 hours during testing, do procedures listed in paragraphs 4.1.1, 4.4, and 4.6.

d. After testing, do procedures listed in 4.1.1 and 4.6. NOTE: Recalibrate all instrumentation at its normal schedule.

4.10.3 Reliability, Availability, Maintainability (RAM).

a. Run the engine for 1000 hours using the appropriate schedule from MIL-STD 1400, and record total fuel consumed.

b. Monitor instrumentation during testing, and record times when the following occur:

(1) Oil added
(2) Oil and filter changed
(3) Air cleaners cleaned or changed
(4) Coolant added
(5) Lubrications (water pump, turbocharger, fuel pump, etc.)
(6) Failures, if any (time required to correct failure; replacement parts required)

5. DATA REQUIRED.

5.1 Maximum Output. Record the following:

5.1.1 Net Horsepower. At each engine speed:

a. Ambient temperature in °C, wet bulb and dry bulb
b. Barometric pressure in in. mercury
c. Engine speed in rpm
d. Dynamometer scale reading in ft-lb
e. Air intake rate in m^3/min
f. Intake air pressure in in. mercury
g. Exhaust pressure in in. mercury
h. Fuel pressure in kPa (psi)
i. Oil pressure in kPa (psi)
j. Intake air temperature in °C
k. Exhaust temperature in °C

l. Fuel temperature in °C
m. Oil temperature in °C
n. Fuel intake rate in kg/hr
o. Spark advance in ° (gasoline engines only)
p. Exhaust smoke analysis

5.1.2 Gross Horsepower. At each engine speed, record data as specified in 5.1.1.

5.2 Accessory Losses. For each accessory and engine speed, record data listed in 5.1.1

5.3 Motoring Friction. Record the following at all motoring speeds:

a. Dynamometer scale reading in kg

b. Oil temperatures in °C

5.4 Blow-by. For each engine speed, record the following:

a. Blow-by in m^3/min

b. Engine speed in rpm

5.5 Fuel Consumption. Record the following for each engine speed and load:

a. Engine speed in rpm
b. Intake air pressure in in. mercury
c. Rack position (diesel engines only)
d. Dynamometer scale reading in kg
e. Fuel intake rate in m^3/min
f. Air intake rate in m^3/min
g. Fuel pressure in kPa

5.6 Octane Requirements. Collect data as described in applicable portions of TOP 2-2-701.

5.7 Cold Starting. Collect data as described in applicable portions of TOP 2-2-650.

5.8 Road Load Economy. Record data as specified in TOP 2-2-603.

5.9 Performance Checks.

5.9.1 Power Checks.

a. Record data specified in 5.1.1.

b. For octane requirements, collect data as specified in TOP 2-2-701.

5.9.2 Calibration.

a. Record data specified in 5.1.1.

b. For fuel consumption at each speed and load, record data as specified in 5.5.

c. For octane requirements, collect data as specified in TOP 2-2-701.

d. For road load economy, record data as specified in 5.10.

5.9.3 Complete Performance. Record data specified in 5.1, 5.2, 5.3, 5.5, 5.6, 5.7, and 5.8.

5.10 Endurance Tests.

5.10.1 Fuel and Lubricant Capability. Collect data specified in applicable portions of TOP 2-2-701.

5.10.2 Acceptability. Record data specified in 5.1.1, 5.4, and 5.6.

5.10.3 RAM. Record data as specified in 4.10.3.b.

6. DATA PRESENTATION. Sample curves are shown in Appendix A.

6.1 Maximum Output.

6.1.1 Net Horsepower.

a. Compute the brake horsepower and brake torque from:

$$\text{Brake horsepower (bhp)} = \frac{NLR}{5252} \quad \text{or} \quad \frac{NL}{K}$$

$$\text{Brake torque} = LR \quad \text{or} \quad \frac{5252\ (\text{bhp})}{N} \quad \text{(lb-ft)}$$

in which: N = engine speed (rpm)
R = dynamometer torque arm (ft)
L = dynamometer scale reading (lb)
K = dynamometer constant

b. Correct the brake torque and brake horsepower readings to standard conditions by multiplying computed values, using the following (corrections apply to full-load data only):

(1) Spark ignition engine.

$$C_s = \frac{29.00}{B_{dt}} \times \sqrt{\frac{T_t + 460}{85 + 460}}$$

(2) Compression ignition engine.

$$C_d = \frac{29.00}{B_{dt}} \times \left(\frac{T_t + 460}{85 + 460}\right)^{0.7}$$

in which: B_{dt} = barometric pressure minus vapor pressure at test condition in in. mercury

C_s = correction factor for SI engines
C_d = correction factor for CI engines
T_t = temperature at test condition in °C (average the four ambient temperatures)

c. Compute the brake specific fuel consumption (bsfc) by:

$$bsfc = \frac{W_f(60)}{T\ (bhp)} \quad lb/hp\text{-}hr \text{ or } \frac{F}{obhp}$$

in which: $W_f = d_f\ V_f$ in lb (weight of fuel)
$V_f = R_f(T)$ in ft^3 (volume of fuel)
F = fuel consumption rate
obhp = observed brake horsepower
V_f = volume of fuel (ft^3)
R_f = intake fuel rate (cfm)
bhp = brake horsepower
d_f = density in lb/ft^3
T = time in hours

d. Compute the fuel air ratios by:

$V_a = R_a(T)$ (volume of air in ft^3)

$W_a = V_a\ d_a$ (weight of air in lb)

$$\text{air consumption} = \frac{W_a\ (60)}{T}$$

$$\text{fuel - air ratio} = \frac{bsfc}{\text{air consumption}}$$

in which: V_a = volume air in ft^3
W_a = weight of air in lb
T = time in minutes
d_a = density of air in lb/ft^3

e. From the data, construct the following curves:

(1) Brake horsepower (corrected) versus engine speed
(2) Brake torque (corrected) versus engine speed
(3) Fuel intake rate versus engine speed
(4) BSFC (observed) versus engine speed
(5) Spark advance versus engine speed (gasoline only)
(6) Intake air pressure versus engine speed
(7) Fuel air ratio versus engine speed
(8) Fuel temperature versus engine speed
(9) Exhaust smoke level versus engine speed (diesel engines only)
(10) Oil temperature versus engine speed
(11) Exhaust pressure versus engine speed

f. Compare the curves to those in specifications.

6.1.2 Gross Horsepower.

a. Compute brake horsepower and brake torque as described in 6.1.1a.

b. Correct brake horsepower and brake torque as described in 6.1.1.b.

c. Compute the bsfc and fuel-air brake torque as described in 6.1.1.c and d.

d. Construct the curves listed in 6.1.1.e.

e. Compare the curves to those in specifications.

6.2 Accessory Losses. Follow instructions in 6.1.2.

6.3 Motoring Friction.

a. Compute friction horsepower as described in 6.1.1.a.

b. Add the friction horsepower to the brake horsepower at the same engine speeds. This yields indicated horsepower (ihp). (Brake horsepower (bhp) at these speeds is derived in earlier tests.)

c. Compute mechanical efficiency by:

$$\text{Mechanical efficiency} = \frac{\text{bhp}}{\text{ihp}}$$

d. Construct the following curves:

(1) Friction horsepower versus engine speed
(2) Indicated horsepower versus engine speed
(3) Mechanical efficiency versus engine speed (on the same graph with indicated horsepower)

6.4 Blow-by.

a. Construct a curve of blow-by versus engine speed.

b. Compare this curve to specifications.

6.5 Fuel Consumption.

a. Compute brake horsepower and brake torque as described in 6.1.1.c.

b. Construct the following curves:

(1) Brake horsepower (observed) versus intake air pressure (constant speed lines)

(2) Brake horsepower (observed) versus rack position (constant speed lines [diesel engines only])

(3) Fuel intake rate (observed) versus intake air pressure or rack position (constant speed lines)

(4) Brake torque versus engine speed (lines of constant horsepower and bsfc superimposed)

c. Compare the curves to those in specifications.

6.6 Octane Requirements. Present data as specified in applicable portions of TOP 2-2-701.

6.7 Cold Starting. Present data as specified in applicable portions of TOP 2-2-650.

6.8 Road Load Economy. Reduce data as specified in TOP 2-2-603.

6.9 Performance Tests.

6.9.1 Power Checks. Present data as described in 6.1.1 and 6.8.

6.9.2 Calibration. Present data as described in 6.1.1, 6.7, 6.8, and 6.10.

6.9.3 Complete Performance. Present data as described in 6.1, 6.2, 6.3, 6.4, 6.5, 6.7, 6.8, 6.9, and 6.10.

6.10 Endurance Tests.

6.10.1 Fuel and Lubricant Compatibility. Present data as described in TOP 2-2-701.

6.10.2 Acceptability.

a. Present data as described in 6.1.1, 6.5, 6.6, and 6.8.

b. Compare the curves to those in specifications and with each other to observe changes during testing.

6.10.3 RAM.

a. Present data acquired from 4.10.3.

b. Average the times for the events, and record this as average time between maintenance.

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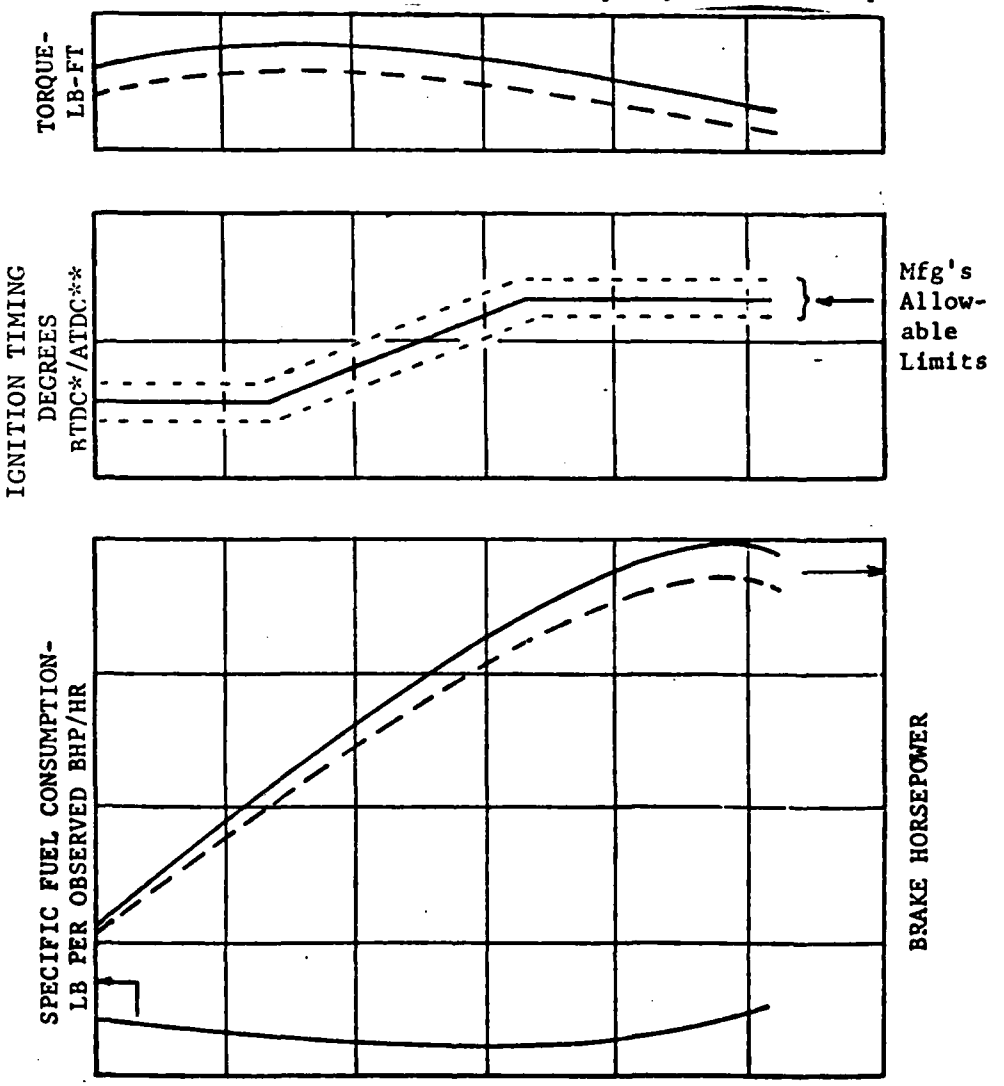
APPENDIX A

SAMPLE CURVES

Operate engine using specification fuel and lubricant, with exhaust pipe, muffler, fan, oil cooler, air cleaner, and generator. Operate generator with no load. Correct horsepower and torque to standard conditions of 30° C (85° F) intake air temperature and 74 cm (29 in.) mercury dry barometric pressure.



*Before top dead center
**After top dead center

_____observed _ _ _ _ _ _ _ _ corrected

Figure A-1. Performance characteristics of engine, type _____, model No. _____, serial No. _____.

Operate engine using specification fuel and lubricant, with exhaust pipe, muffler, fan, oil cooler, air cleaner, and generator. Operate generator with no load.

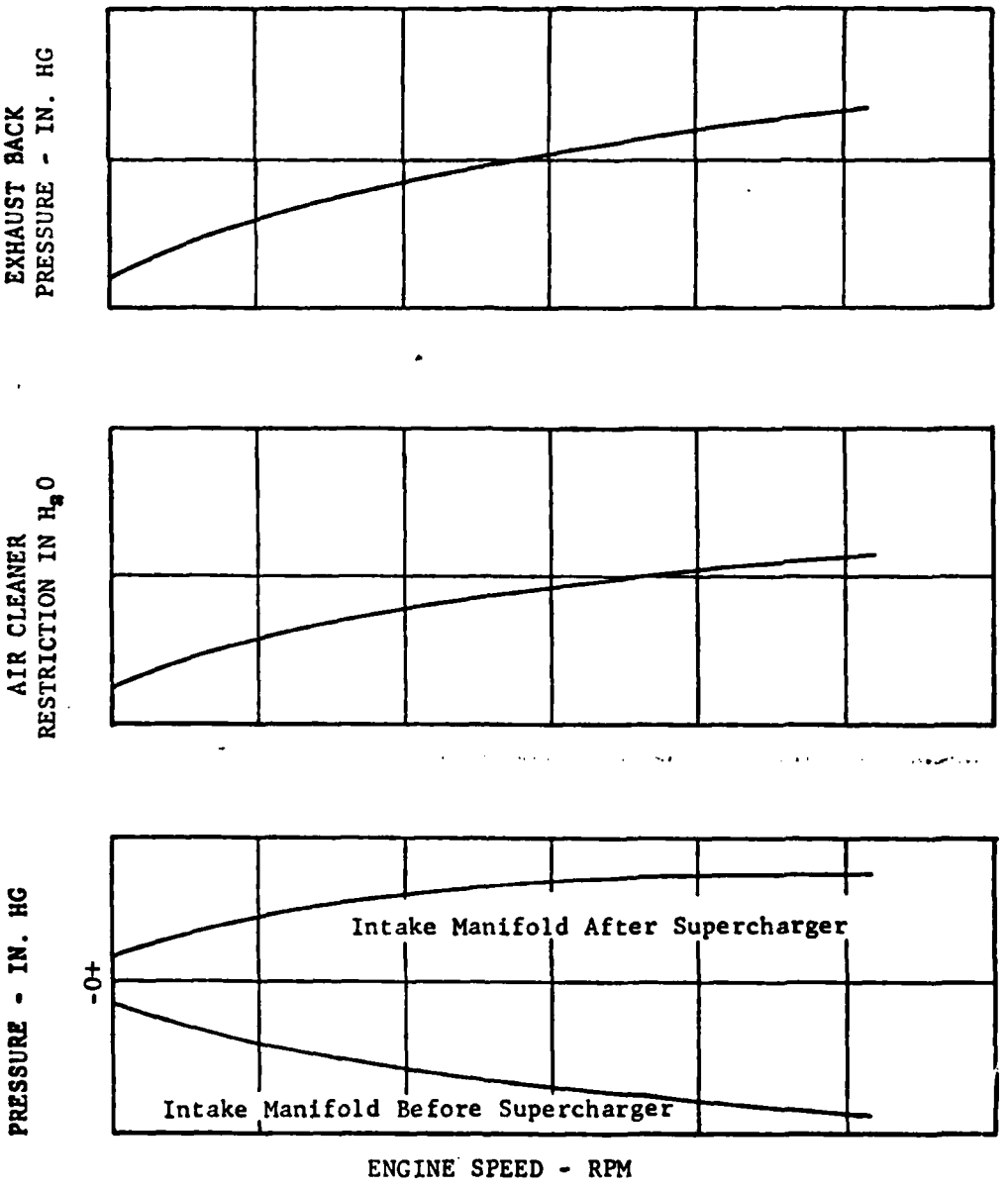


Figure A-2. Performance characteristics of engine, type _____, model No. _____, serial No. _____.

Operate engine using specification fuel and lubricant, with exhaust pipe, muffler (chamber or test item), fan, oil cooler, air cleaner, and generator. Operate generator with no load.

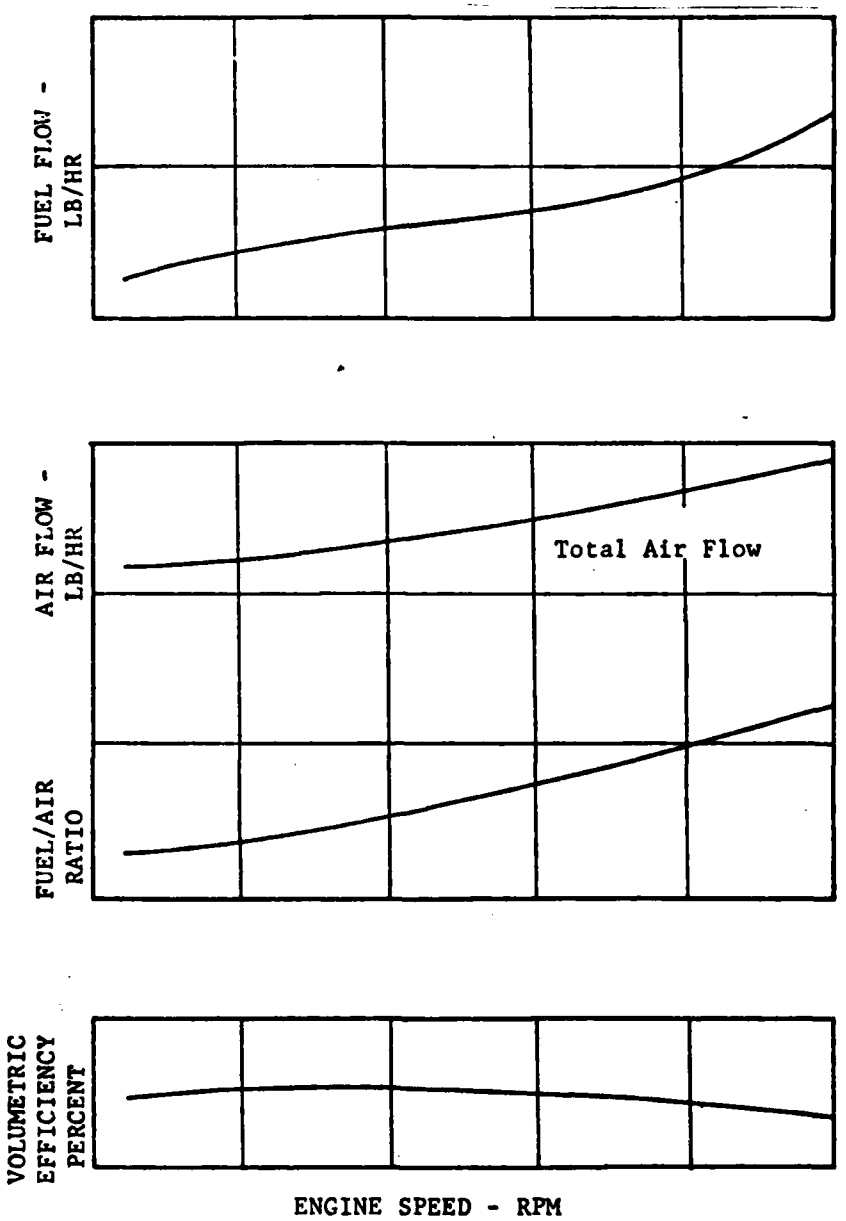


Figure A-3. Performance characteristics of engine, type _____, model No. _____, serial No. _____.

Operate engine using specification fuel and lubricant, with exhaust pipe, muffler (chamber or test item), fan, oil cooler, air cleaner, and generator. Operate generator with no load. Correct horsepower and torque to standard conditions of 30° C intake air temperature and 29 in. mercury dry barometric pressure.

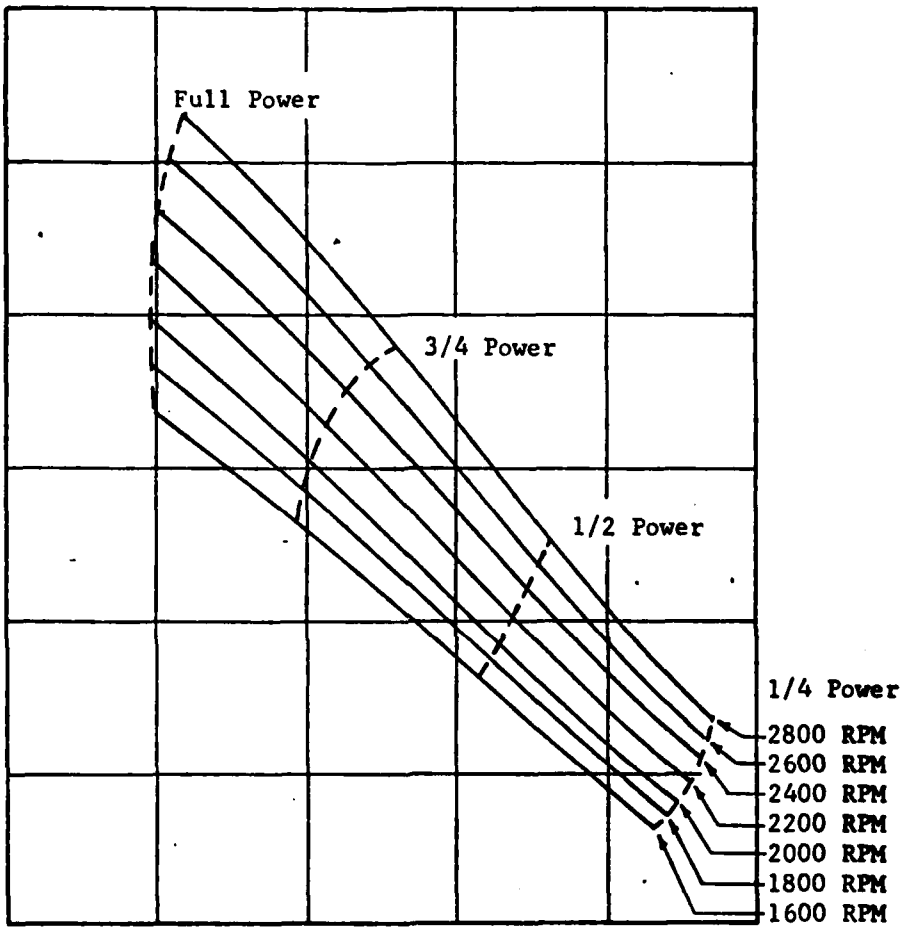


Figure A-4. Performance characteristics of engine, type _____, *model No. _____, serial No. _____.

*This curve generally is used for gasoline engines only.

Operate engine using specification fuel and lubricant, with exhaust pipe, muffler (chamber or test item), fan, oil cooler, air cleaner, and generator. Operate generator with no load. Correct horsepower and torque to standard conditions of 30° C intake air temperature and 29 in. mercury dry barometric pressure.

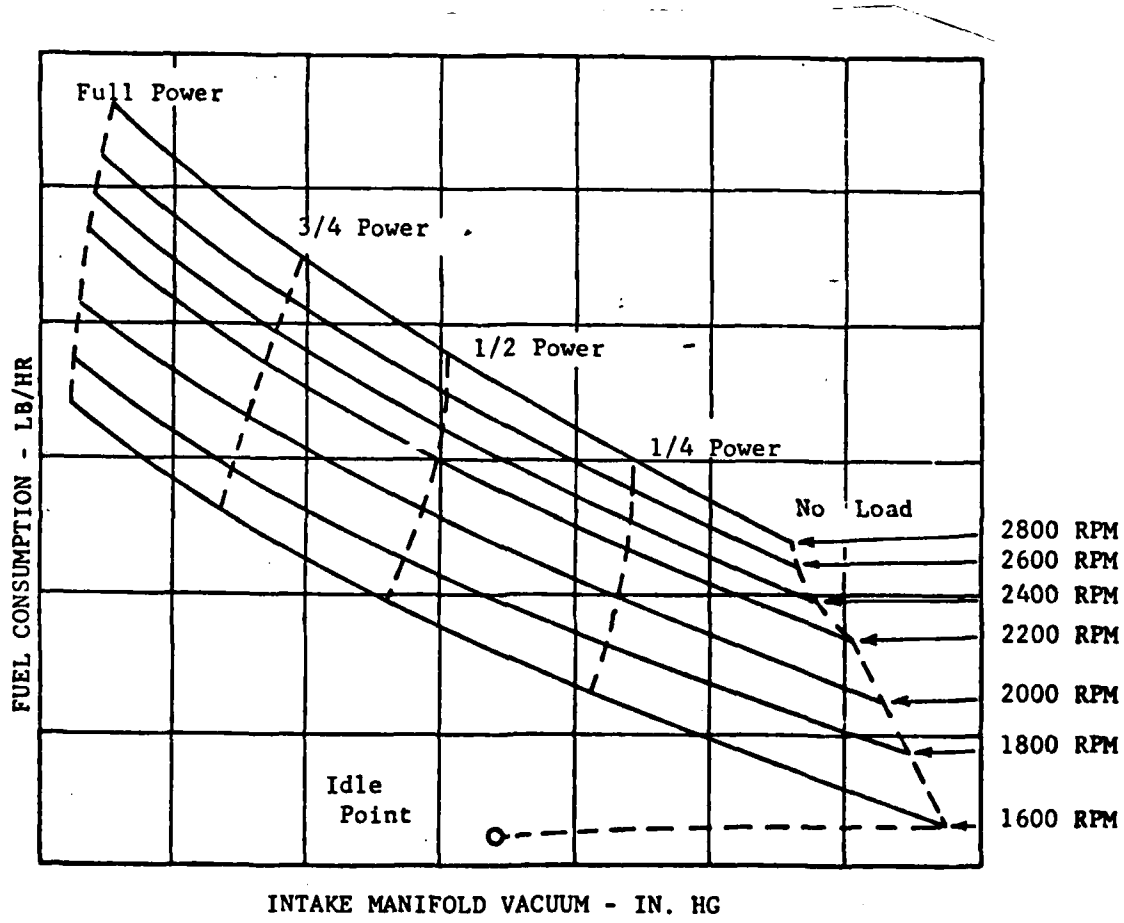
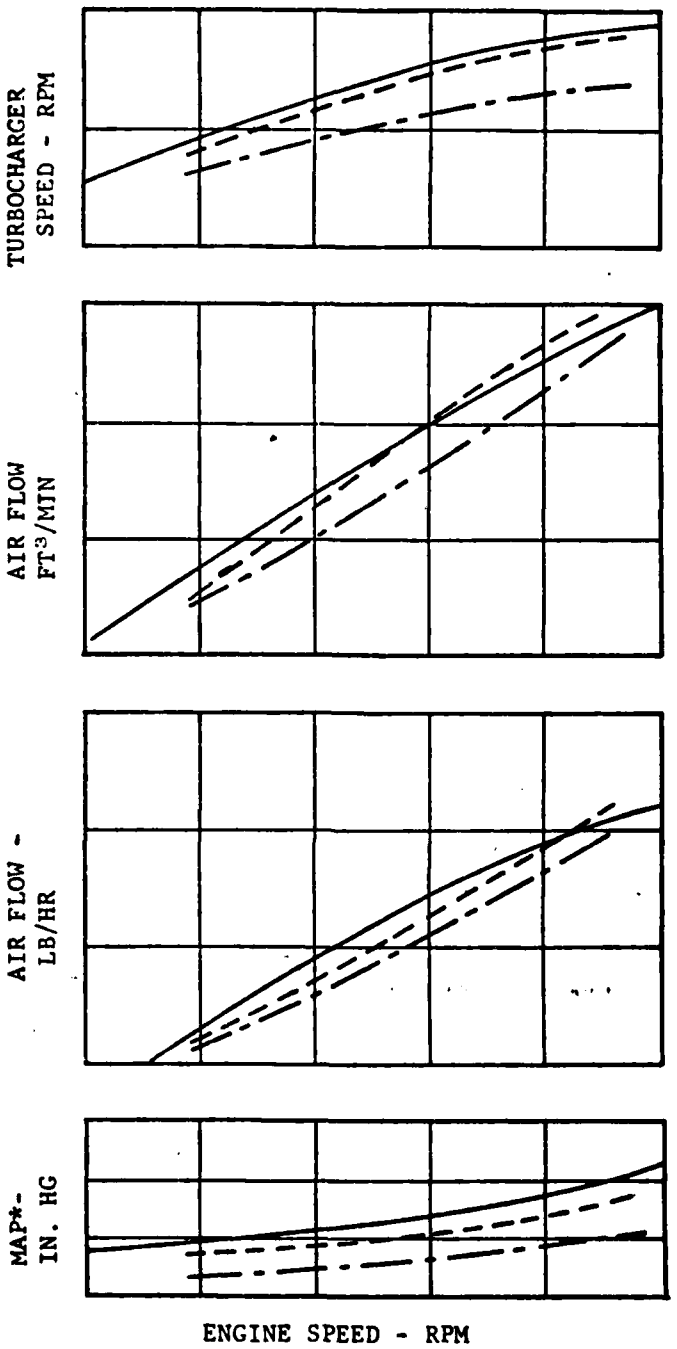


Figure A-5. Performance characteristics of engine, type _____, *model No. _____, serial No. _____.

*This curve generally is used for gasoline engines only.



*Manifold absolute pressure

_____ DF-2 (diesel fuel No. 2)
— — — — CITE (compression-ignition and turbine engine)
— - — - — Gasoline

Figure A-6. Performance characteristics of engine, type _____, model No. _____, serial No. _____.

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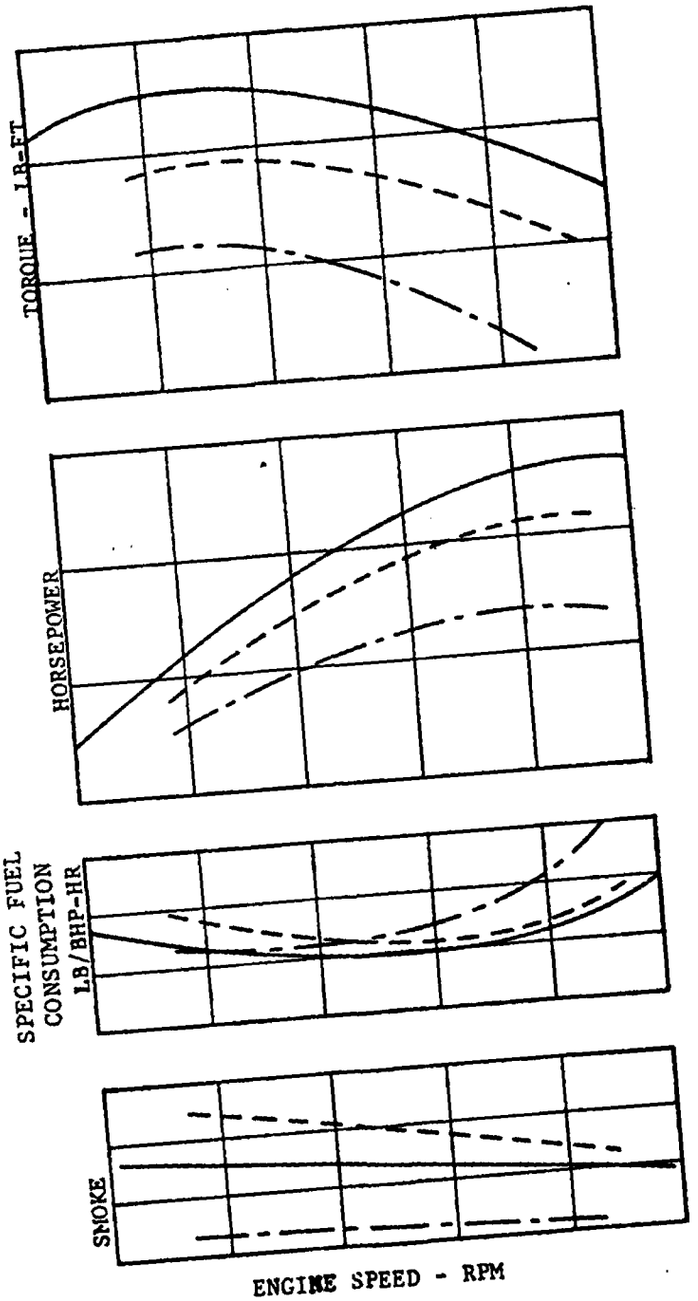
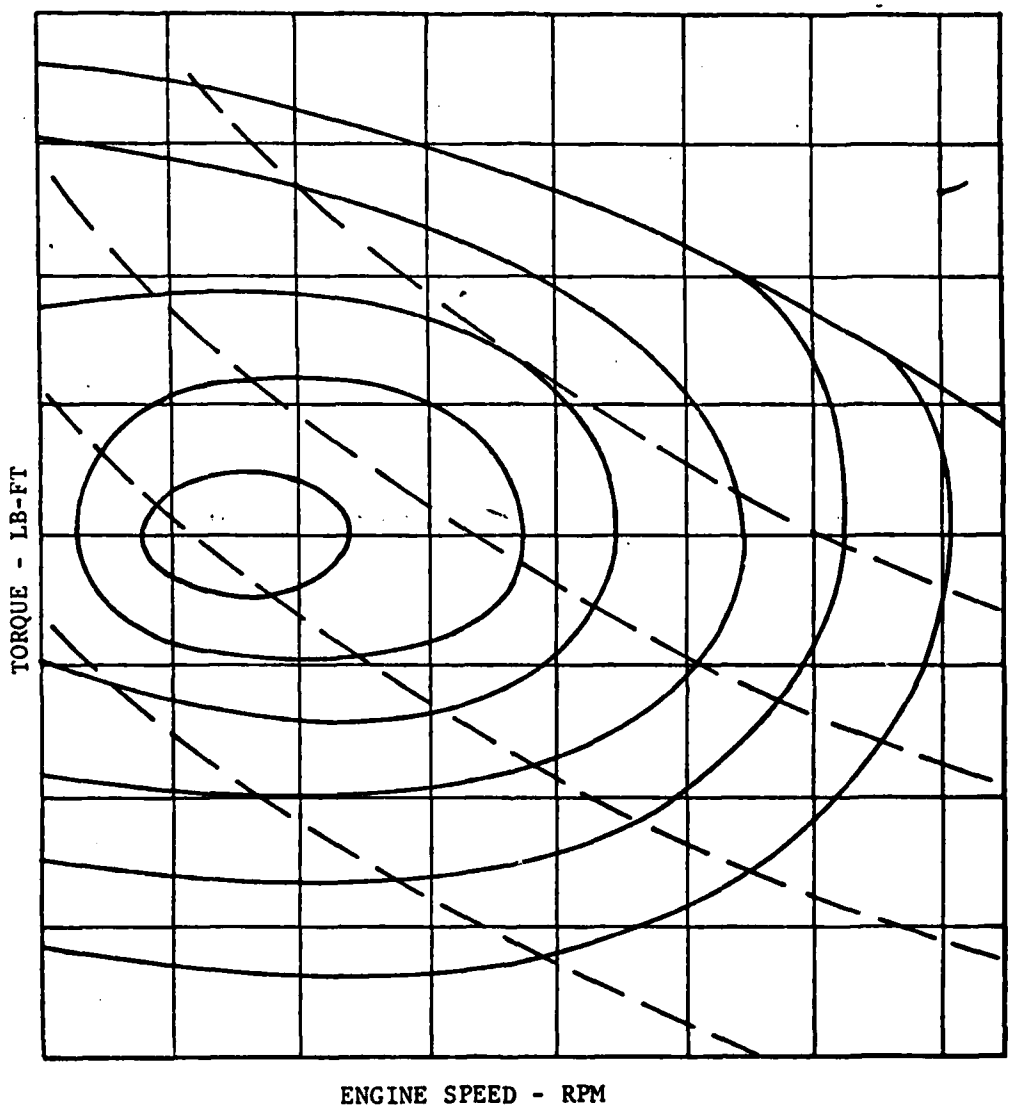


_____ DF-2 — — — CITE ——— Gasoline

Figure A-7. Performance characteristics of engine, type _____, model No. _____, serial No. _____.



_____ Lines of constant specific fuel consumption

___ ___ ___ Lines of constant horsepower

Figure A-8. Performance characteristics of engine, type _____, model No. _____, serial No. _____.

APPENDIX B

REFERENCES

1. MTP 2-2-703, Laboratory Tests of Power Train Components, 19 January 1966.

2. MIL-STD 1400B, Engines, Gasoline and Diesel, Methods of Test, December 19, 1975.

3. MTP 2-1-002, Automotive Laboratory Instrumentation, 15 July 1968.

4. TOP 2-2-701, Fuels and Lubricants, 2 July 1976.

5. TOP 2-2-650, Engine Cold Starting and Warmup Tests, 18 July 1980.

6. TOP 2-2-603, Vehicle Fuel Consumption, 12 February 1980.

7. MIL-E-45162B, Engines, Gasoline, 4- and 6-cylinder Horizontal, Opposed and 12-cylinder, 90° V-type, and others, July 24, 1963.

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